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Marin Sports Academy
c/o Mr. Scott Mendelson
50 Queva Vista
Novato, California 94947

Re: Geologic and Geotechnical Feasibility Evaluation
Marin Sports Academy
Novato, California

Introduction

This letter summarizes the results of our Phase 1 Geologic and Geotechnical Feasibility Evaluation for the proposed Marin Sports Academy complex in the former Hamilton Field area of Novato, California. A site location map is shown on Figure 1. The purpose of our Phase 1 services is to evaluate existing site conditions and geologic hazards which may affect the project, develop an opinion regarding project feasibility from a geotechnical perspective, and provide general development guidelines for use in project planning and preliminary design.

The scope of our Phase 1 services is described in our proposal letter dated October 16, 2014, and includes review of geologic and geotechnical background information from our in-house library and as made available by you, performance of a detailed site reconnaissance to observe existing conditions, evaluation of geologic hazards and conceptual mitigation measures, development of preliminary geotechnical recommendations for use in project planning, and preparation of this summary report. Issuance of this report completes the scope of our Phase 1 services.

Project Description

The project includes redevelopment of the former Hamilton Air Force Base Landfill 26 as a regional youth-sports complex. Preliminary plans indicate that primary project features will include a new lighted 1,500-seat baseball stadium in the northern portion of the site, 4 baseball fields in a cloverleaf pattern in the central part of the site, and 2 new international-size soccer fields, a youth soccer field, and a Little League baseball field in the southern part of site. A new “Future Prospects” baseball academy and Marin Sports Hall of Fame will utilize a new indoor facility comprising between about 25,000 and 65,000 square feet and sited west of the cloverleaf ballfields. Site access will be provided by a new paved access road extending north from Hamilton Parkway, with a new vehicle bridge spanning Pacheco Creek. A new building will be constructed to house an Army Corps of Engineers office and Hamilton Wetlands Restoration interpretive center within a new 300-foot wide wildlife corridor bordering the northeastern site boundary. Ancillary improvements will include new snack bars and restrooms, new underground utilities, lighting, landscaping, exterior walkways and flatwork, and other minor items. We understand that project development is still underway, and that exact improvements and roadway alignments are subject (and likely) to change as project design advances. A preliminary site plan indicating the approximate locations of proposed improvements as of this publication is shown on Figure 2.

Review of Reference Documents

We have reviewed reference materials you provided in order to glean information regarding the site's development and land-use history, existing subsurface conditions, and geotechnical constraints on future development. Documents we reviewed include the following:

- US Army Corps of Engineers (USACE)(2011), "Final Closure and Postclosure Maintenance Plan for Landfill 26, Former Hamilton Army Airfield, Novato, California" (including Appendices A through Q, which generally compile previous environmental and geotechnical consultant reports)

Site Development and Land-Use History

Hamilton Airfield (later Hamilton Army Airfield and Hamilton Air Force Base) was originally constructed in the early 1930's, serving as an active Army Air Corps base for fighter, bomber, and transport aircraft through the 1940's and served as a staging area for Pacific Theater operations during World War II. Landfill 26 began accepting refuse in the early 1940's, and our review of USACE's maintenance plan indicates that landfill waste consists primarily of commercial and construction debris, aircraft parts, scrap metal, and buried culverts. Methods of disposal were apparently undocumented, and the landfill remained active until 1974, when the Hamilton Airfield was deemed surplus property by the US Department of Defense. Following sale of large parts of Hamilton Airfield to private developers, Landfill 26 was provided with a final cap in accordance with the Resource Conservation and Recovery Act (RCRA), which was constructed in 1994 and 1995. Since construction of the RCRA-type cap, adjacent lands to the south and southeast, beyond the 22-foot landfill perimeter buffer zone, have been redeveloped with single-family residential units and associated municipal infrastructure.

Regional Geology

The project site is located in the Coast Ranges geomorphic province of California, which is typified by generally northwest-trending ridges and intervening valleys formed as a result of movement along a group of northwest-trending fault systems, including the San Andreas Fault. Bedrock geology within Marin County is dominated by sedimentary, igneous, and metamorphic rocks of the Jurassic-Cretaceous age Franciscan Complex. Sandstone and shale comprise the majority of Franciscan rock types, while less common rocks include chert, serpentinite, basalt, greenstone, and exotic low- to high-grade metamorphic rocks, including phyllite, schist, and eclogite.

Regional geologic mapping[1] indicates that the majority of the project site is underlain by Quaternary (geologically young) alluvial deposits, which are typically comprised of varying proportions of unconsolidated clay, silt, sand, and gravel deposited in stream channel, fan, or floodplain environments. The northeast portion of the site is mapped as being underlain by fill over bay mud, which typically consists of soil, rock, rubble, and or garbage and other debris fill over soft, compressible silty clay. The north-eastern most portion of the site, is shown as being underlain by sandstone bedrock of the Franciscan Complex. A regional geologic map is shown on Figure 3.

[1] Rice, S.R. et al (2002), "Geologic Map of the Novato 7.5' Quadrangle, Marin and Sonoma Counties, California: A Digital Database, Version 1.0", California Department of Conservation, California Geological Survey, Map Scale 1:24,000.

Seismicity

The project site is located within the seismically active San Francisco Bay Area and will therefore experience the effects of future earthquakes. Earthquakes are the product of the build-up and sudden release of strain along a “fault” or zone of weakness in the earth's crust. Stored energy may be released as soon as it is generated or it may be accumulated and stored for long periods of time. Individual releases may be so small that they are detected only by sensitive instruments, or they may be violent enough to cause destruction over vast areas.

Faults are seldom single cracks in the earth's crust but typically comprised of localized shear zones which link together to form larger fault zones. Within the Bay Area, faults are concentrated along the San Andreas Fault zone. The movement between rock formations along either side of a fault may be horizontal, vertical, or a combination and is radiated outward in the form of energy waves. The amplitude and frequency of earthquake ground motions partially depends on the material through which it is moving. The earthquake force is transmitted through hard rock in short, rapid vibrations, while this energy becomes a long, high-amplitude motion when moving through soft ground materials, such as bay mud.

1. Active Faults in the Region - Such earthquakes could occur on any of several active faults within the region. An “active” fault is one that shows displacement within the last 11,000 years (i.e. Holocene) and has a reported average slip rate greater than 0.1 mm per year. The California Division of Mines and Geology (1998) has mapped various active and inactive faults in the region. These faults, defined as either California Building Code Source Type “A” or “B,” are shown in relation to the project site on the attached Active Fault Map, Figure 4.

2. Historic Fault Activity - Numerous earthquakes have occurred in the region within historic times. The results of our computer database search indicate that at least 32 earthquakes (Richter Magnitude 5.0 or larger) have occurred within 100 kilometers (62 miles) of the site area between 1769 and 2014. The six most significant historic earthquakes to affect the project site are summarized in Table A.

TABLE A
SIGNIFICANT EARTHQUAKE ACTIVITY
Marin Sports Academy
Novato, California

Epicenter (Latitude, Longitude)	Historic Richter Magnitude	Year	Distance
37.80, -122.20	6.8	1836	40 km
37.60, -122.40	7.0	1838	52 km
37.70, -122.10	6.8	1868	54 km
38.20, -122.40	6.2	1898	19 km
37.70, -122.50	8.3	1906	40 km
38.22, -122.31	6.0	2014	25 km

Reference: United States Geological Survey (2009), Earthquake Hazards Program," Earthquake Circular Area Search", http://neic.usgs.gov/neis/epic/epic_circ.html, accessed June 11, 2009.

3. Probability of Future Earthquakes – The site will likely experience moderate to strong ground shaking from future earthquakes originating on active faults in the San Francisco Bay region. The historical records do not directly indicate either the maximum credible earthquake or the probability of such a future event. To evaluate earthquake probabilities in California, the USGS has assembled a group of researchers into the "Working Group on California Earthquake Probabilities"[2,3] to estimate the probabilities of earthquakes on active faults. The results of these studies have been respectively published as the Uniform California Earthquake Rupture Forecasts, Versions 1 and 2 (UCERF and UCERF 2). In these studies, potential sources were analyzed considering fault geometry, geologic slip rates, geodetic strain rates, historic activity, and micro-seismicity, to arrive at estimates of earthquakes of various magnitudes on a variety of faults in California.

The 2003 study (UCERF) specifically analyzed fault sources and earthquake probabilities for the seven major regional fault systems in the Bay Area region of northern California. The 2008 study (UCERF 2) applied many of the analyses used in the original UCERF to the entire state of California, in addition to updating some of the analytical methods and models.

In addition to the seven major Bay Area regional fault systems, the 2003 study included probabilities of "background earthquakes." These earthquakes are not associated with the identified fault systems and may occur on lesser faults (i.e., West Napa) or previously unknown fault traces (i.e., the 1989 Loma Prieta and 2000 Mt. Veeder - Napa

[2] United States Geological Survey (2003), "Summary of Earthquake Probabilities in the San Francisco Bay Region, 2002 to 2032," The 2003 Working Group on California Earthquake Probabilities, 2003.
[3] United States Geological Survey (2008), "The Uniform California Earthquake Rupture Forecast, Version 2," The 2007 Working Group on California Earthquake Probabilities, Open File Report 2007-1437, 2008.

earthquakes). When the probabilities on all seven fault systems and the background earthquakes are combined mathematically in conjunction with the updated models and analytics from the 2008 study, there is a 63 percent chance for a magnitude 6.7 or larger earthquake to occur in the Bay Area by the year 2036. Smaller earthquakes (between magnitudes 6.0 and 6.7), capable of considerable damage depending on proximity to urban areas, have about a 92 percent chance of occurring in the Bay Area by 2036 (USGS, 2008).

Conclusions from the 2008 UCERF 2 indicate that the mean probability of an M>6.7 earthquake in all of California by 2036 are 99.7%, while northern California specifically has lower odds of about 93%. Additionally, UCERF 2 assigns probabilities of an M>6.7 event on each of the nearest mapped active faults by 2036, the Hayward and Rodgers Creek Faults, of 31%.

Additional studies by the USGS regarding the probability of large earthquakes in the Bay Area are ongoing. These current evaluations include data from additional active faults and updated geological data.

Site Reconnaissance and Surface Conditions

We performed a site reconnaissance on November 14, 2014, to observe and document existing geologic and geotechnical conditions at the site and for evaluation of significant geotechnical issues to be considered during project development. The most significant observations made during our site reconnaissance are discussed below.

- The banks of Pacheco Creek are heavily overgrown with blackberry, Pampas grass, and mature oak and willow trees, and we were unable to directly observe creekbank conditions at the currently-proposed location of the access road bridge. Based on observations made of creekbank conditions at the Hamilton Parkway crossing, we anticipate that banks at the proposed bridge location are on the order of about 6- to 7-feet high and inclined between about 2:1 (horizontal:vertical) and 3:1.

- The access road alignment south of Pacheco Creek would cross relatively level, undeveloped lands which are vegetated mainly with low grasses and not anticipated to present any significant geotechnical challenges. The alignment north of the creek would follow, for a distance of a few hundred feet, an existing, relatively narrow asphalt-paved roadway before emerging into an area currently developed with 5 concrete slabs (former Army munitions bunkers) and surround asphalt pavements. Near the north end of the munitions depot area, the road alignment bends to the northeast, crossing an existing low-lying area which appears to be seasonally flooded and vegetated with low grasses. This area is likely underlain by soft marsh deposits, and would require stabilization and filling for roadway development.

- Landfill cap perimeter slopes are generally inclined at about 4:1, range in height from about 2 to 15-feet, and do not exhibit any evidence of existing instability or significant erosion. Side slopes are generally underlain by loose to medium-dense clayey sand, which were noted to be subjected to minor to moderate erosion due to rodent burrowing and potential subsurface “piping” along the northeast side of the site at the far northeastern corner, opposite the nursery, where soils appear to have been disturbed by previous grading or mowing activity.

- The “interior” of the landfill cap area is gently sloping on the order of about 10:1. A drainage swale has been graded into the cap in the northeast part of the site, which slopes down toward the northeast at the location of an existing gabion-protected 12-inch corrugated plastic pipe outfall. This area would likely require new fills on the order of about 8- to 10-feet adjacent to existing landfill to achieve uniform grades suitable for new athletic fields.

- Lower-lying areas along the southeast portion of the landfill cap are vegetated with low grasses and sparse Pampas grass, and appear susceptible to seasonal flooding given surrounding grades. This area would likely require new fills on the order of about 6- to 10-feet thick to achieve uniform grades suitable for the west end of the soccer fields currently shown at that location.

- The “high points” of the landfill cap appears to be at the north corner, where a new baseball stadium is shown on preliminary plans and at about mid-point on the east side of the landfill. The cap is about 15-feet above the surrounding grades at these locations. Fills of similar thickness would be required to achieve uniform grades for the baseball fields and associated improvements. Existing channels and wetlands along the northeast-facing slope at this location were filled with water at the time of our reconnaissance.

<u>Generalized Subsurface Conditions</u>

Review of the reference material cited above (USACE, 2011) indicates that areas within the footprint of Landfill 26 are, in generalized order of increasing depth, underlain by the following materials:

- Final RCRA-Type Landfill Cover
  - Vegetative Soil Layer
    - Vegetation and 6-inches of topsoil
    - 18- to 30-inches of clayey sand “select fill”
    - Polypropylene geotextile
    - Geosynthetic drainage net
  - Hydraulic Barrier Layer
    - 40-mil polyethylene geomembrane
    - 12- to 24-inches of compacted clay
  - Foundation Layer
    - 2- to 4.5-feet of “random fill”
- Refuse
  - Generally 5- to 10-feet thick, including aircraft parts, scrap metal, construction/demolition debris, and petroleum-contaminated soils from oil spill cleanup activities

- Alluvial Soils
    - Generally 8- to 16-feet of bay mud over 15- to 21-feet of sand, silty sand, and clayey sand (Northern landfill area)
    - 0- to 6-feet of gray clay over 2- to 6-feet of sand and clayey sand (Southern landfill area)
- Weathered arkosic sandstone with lesser interbedded shale and mudstone.

Geologic Hazards

This section summarizes our review of commonly considered geologic hazards, discusses their potential impacts on the planned improvements, and identifies proposed mitigation options. The primary geologic hazards which could affect development of the project site are strong ground shaking, potential liquefaction, settlement, flooding and surface erosion. Other geologic hazards, as discussed below, are deemed less than insignificant at the site.

Fault Surface Rupture

Under the Alquist-Priolo Earthquake Fault Zoning (APEFZ) Act[4], the California Division of Mines and Geology (CDMG, now known as the California Geological Survey) produced 1:24,000 scale maps showing known active and potentially active faults and defining zones within which special fault studies are required[5]. The nearest known active fault, the Hayward Fault, is located approximately 12-km to the east-southeast, and the site is not mapped as lying within an Alquist-Priolo Earthquake Fault Zone. Therefore, the likelihood of fault surface rupture at the site is remote.

Evaluation: *Less than significant.*
Mitigation: *No mitigation measures are required.*

Seismic Shaking

The site will likely experience seismic ground shaking similar to other areas in the seismically active Bay Area. The intensity of ground shaking will depend on the characteristics of the causative fault, distance from the fault, the earthquake magnitude and duration, and site specific geologic conditions. Estimates of peak ground accelerations are based on either deterministic or probabilistic methods.

Deterministic methods use empirical attenuation relations provide approximate estimates of median peak ground accelerations. A summary of the active faults that could most significantly affect the planning area, their maximum credible magnitude, closest distance to the center of the planning area, and probable peak ground accelerations are summarized in Table B.

[4] California Department of Conservation, Division of Mines and Geology (1972), Special Publication 42, "Alquist-Priolo Special Studies Zone Act," (Revised 1988).

[5] California Department of Conservation, Division of Mines and Geology (2000), "Digital Images of Official Maps of Alquist-Priolo Earthquake Fault Zones of California, Central Coast Region", DMG CD 2000-004.

TABLE B
ESTIMATED PEAK GROUND ACCELERATION
FOR PRINCIPAL ACTIVE FAULTS
Marin Sports Academy
Novato, California

Fault	Moment Magnitude for Characteristic Earthquake	Closest Estimated Distance (kilometers)	Median Peak Ground Acceleration (g)[1]
Hayward	7.3	12	0.26
Rodgers Creek	7.3	13	0.24
San Andreas	8.0	21	0.23
San Gregorio	7.4	23	0.19
West Napa	6.6	26	0.13

1) Values determined using Vs^{30} = 180 m/s for “soft clay soils” (Site Class “E”) in accordance with the 2013 California Building Code.

Reference: Caltrans (2014), ARS Online (web-based acceleration response spectra calculator tool), http://dap3.dot.ca.gov/ARS_Online/, accessed November 12, 2014.

The calculated bedrock accelerations should only be considered as reasonable estimates. Many factors (soil conditions, orientation to the fault, etc...) can influence the actual ground surface accelerations.

Ground shaking can result in structural failure and collapse of structures or cause non-structural building elements, such as light fixtures, shelves, cornices, etc., to fall, presenting a hazard to building occupants and contents. Compliance with provisions of the California Building Code (CBC) should result in structures that do not collapse in an earthquake. Damage may still occur and hazards associated with falling objects or non-structural building elements will remain.

The potential for strong seismic shaking at the project site is high. Due to their proximity and historic rates of activity, the Hayward, Rodgers Creek, and San Andreas Faults present the highest potential for severe ground shaking. The significant adverse impact associated with strong seismic shaking is potential damage to structures and improvements.

Evaluation: *Less than significant with mitigation.*

Mitigation: *Minimum mitigation includes design of new structures in accordance with the provisions of the 2013 California Building Code. Preliminary recommended seismic design coefficients are presented in the Conclusions and Recommendations section of this report. These criteria should be confirmed, on the basis of existing subsurface information or, if necessary, new exploration and laboratory testing performed as part of a future design-level geotechnical investigation.*

Liquefaction and Lateral Spreading
Liquefaction refers to the sudden, temporary loss of soil strength during strong ground shaking. This phenomenon can occur in saturated, loose, granular deposits (typically sand) when the sediments are subjected to seismic shaking. Liquefaction can result in flow failure, lateral spreading, and settlement.

Regional mapping[6] indicates that the majority of the project site, including those areas mapped as being underlain by alluvial soils, lies in a zone of "moderate" liquefaction susceptibility, while areas underlain by fill over may mud and bedrock are mapped as lying within zones of "very high" and "low" susceptibility, respectively, and as shown on Figure 5.

Based on experience with similar sites, bay mud is generally non-liquefiable, and regional-scale mapping tends to overstate liquefaction susceptibility in areas underlain by bay mud. However, bay mud deposits commonly contain discontinuous seams and lenses of saturated granular materials, which may result in a locally higher susceptibility to liquefaction. Subsurface exploration performed previously by others indicates that loose, saturated, granular deposits are present beneath portions of the site. Therefore, we judge the risk of damage due to liquefaction is low to moderate. Given the moderately thick "cap" of non-liquefiable landfill refuse and environmental cap soils, we judge the likelihood that liquefaction could result in significant surface damage is generally low.

Evaluation: *Less than significant with mitigation.*
Mitigation: *Since deep foundation construction will not be allowed within the limits of the former Landfill 26, new structures located within the limits of the former landfill should be provided with rigid shallow foundations capable of spanning zones of non-uniform support and reducing the potential for damage due to post-liquefaction total and differential settlements. Localized damage to lightly-loaded improvements and field areas arising from sand boils or other minor liquefaction effects could likely be repaired relatively inexpensively. Depending on the nature and extent of ultimately-proposed improvements, liquefaction analysis may be required as part of a future design-level investigation in order to develop appropriate mitigation recommendations for specific improvements. Additional discussion and preliminary recommendations for new foundations and liquefaction mitigation are presented in the Conclusions and Recommendations section of this report.*

Seismically-Induced Ground Settlement
Ground shaking can induce settlement of loose granular soils. Regional geologic mapping indicates that the majority of the project site is underlain by relatively young alluvial soils, which likely contain zones of loose granular materials. Additionally, the composition and nature of underlying landfill waste is generally unknown, but landfill waste may also contain loose granular materials if not well-compacted during original placement. Therefore, the risk of seismically-induced ground settlement at the site is judged low to moderate.

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[6] Association of Bay Area Governments (ABAG)(2014), "Interactive Liquefaction Susceptibility Maps", http://gis.abag.ca.gov/website/Hazards/?hlyr=liqSusceptibility, accessed November 14, 2014.

Evaluation: *Less than significant with mitigation.*
Mitigation: *Foundations for new improvements located in areas underlain by alluvial soils and landfill waste should be designed to span zones of non-uniform support and resist damage due to total and differential settlements which may occur following seismic event. Additional discussion regarding settlement mitigation and preliminary foundation recommendations are presented in the Conclusions and Recommendations section of this report.*

Lurching and Ground Cracking
Lurching and associated ground cracking can occur during strong ground shaking. The ground cracking generally occurs along the tops of slopes where stiff soils are underlain by soft deposits or along steep slopes or channel banks. These conditions are present in the northern portion of the site, as the existing landfill cap is underlain by soft bay mud and alluvial soils. Therefore, the risk of lurching and ground cracking during a seismic event is moderate.

Evaluation: *Less than significant with mitigation.*
Mitigation: *Depending on the nature, location and extents of ultimately-proposed improvements, additional analyses will likely be required as part of a future design-level geotechnical investigation to determine appropriate mitigation for lurching and ground cracking, which would generally consist of minimum setbacks from the top of adjacent slopes. Previous analyses by the Corp indicated adequate factors of safety against seismic displacements are achieved after consolidation of the underlying bay mud. Additional discussion and preliminary guidelines for mitigation of lurching/ground cracking concerns are presented in the Conclusions and Recommendations section of this report.*

Expansive Soils
Moderate and highly plastic silts and clays, when located near the ground surface, can exhibit expansive characteristics (shrink-swell) that can be detrimental to structures and flatwork during periods of fluctuating soil moisture content. Our review of reference information does not indicate expansive soils will be encountered near the ground surface, and the risk of damage due to expansive soil behavior is therefore low.

Evaluation: *Less than significant.*
Mitigation: *No mitigation measures are required.*

Landsliding and Slope Stability
The project site is located in relatively level terrain flanked to the east and northwest by moderately-sloping hills underlain by relatively shallow bedrock. Regional geologic mapping does not indicate the presence of any landslides in adjacent hilly terrain, and no evidence suggestive of imminent instability was observed in these areas during our reconnaissance.

Existing landfill cap slopes are inclined at approximately 4:1 and do not exhibit evidence of historic or incipient instability. New “wedge” fills placed adjacent to existing landfill slopes, especially where they are underlain by bay mud in the northern portions of the site, may be susceptible to slope instability, particularly during a seismic event. In addition, while we were unable to directly observe creekbank conditions in the vicinity of the proposed Pacheco Creek vehicle bridge, our observations at the existing Hamilton Parkway crossing suggest creekbanks will be moderately steep and expose medium-stiff native alluvial soils which could be prone to instability due to channel erosion, scour, or application of new loads. Therefore, while we judge the risk of landslides originating offsite is generally low, the risk of damage to improvements is low to moderate.

Evaluation: *Less than significant with mitigation.*
Mitigation: *Slope-stability analyses should be performed as part of a future design-level investigation to confirm that planned fills and slopes have adequate factors of safety against instability. Wick drainage in the thicker bay mud areas could be used to accelerate consolidation of the bay mud and improve stability. Additional discussion and preliminary guidelines for new fill slopes construction and mitigation of potential instability are presented in the Conclusions and Recommendations section of this report.*

Erosion
Sandy soils on moderately steep slopes or clayey soils on steep slopes are susceptible to erosion when exposed to concentrated surface water flow. The potential for erosion is increased when established vegetation is disturbed or removed during normal construction activity. Surface soils at the site generally consist of loose to medium dense sands and silts; however, slopes are generally relatively gentle. We did not observe any evidence of significant erosion that would affect the proposed improvements during the course of our site reconnaissance. Therefore, we judge the risk of damage to improvements due to erosion is generally low.

Evaluation: *Less than significant with mitigation.*
Mitigation: *For new improvements at the site, careful attention should be paid to finished grades and the project Civil Engineer should design the site drainage system to collect surface water into a storm drain system and discharge water at appropriate locations. Re-establishment of vegetation on disturbed areas will minimize erosion. Erosion control measures during and after construction should be in accordance with a prepared Storm Water Pollution Prevention Plan and should conform to the most recent version of the California Stormwater Quality Association (CASQA) Construction Best Management Practice Handbook (2009).*

Seiche and Tsunami
Seiche and tsunamis are short duration earthquake-generated water waves in enclosed bodies of water and the open ocean, respectively. The extent and severity of a seiche would be dependent upon ground motions and fault offset from nearby active faults.

Site elevations range from approximately 5 to 25 feet above sea level and lies more than 1.5-miles from the open waters of San Francisco bay. While the site is located adjacent to the tidally-influenced Hamilton Wetlands, the wetlands area is separated from the site by an existing flood-control levee, and regional mapping[7] indicates the site lies more than 1.5-miles west of the nearest anticipated inundation zone as shown on Figure 6. Therefore, we judge the risk of inundation due to seiche or tsunami is generally low.

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[7] California Emergency Management Agency (CalEMA)(2009), Tsunami Inundation Map for Emergency Planning, State of California – County of Marin, Novato Quadrangle, Petaluma Point Quadrangle", Map Scale 1:24,000, effective July 1, 2009.

Evaluation: *Less than significant.*
Mitigation: *No mitigation measures are required.*

Flooding
The primary adverse impact from flooding is water damage to structures. Site elevations range from approximately 5 to 25 feet above sea level, and portions of the site proximal to Pacheco Creek and existing drainage ditches and swales along the northeastern and western site boundaries are mapped regionally[8] as lying within a FEMA 100-year flood zone. Other areas, including most of the western and central parts of the site, are mapped as lying within a 500-year flood zone as shown on Figure 7. Therefore, the risk of flooding is judged moderate to high.

Evaluation: *Less than significant with mitigation.*
Mitigation: *New improvements should be set back sufficiently from the drainage channel at the northern property boundary and site grades designed to prohibit ponding of water around structures during small-scale events. Finished floor elevations within structures should be above the projected 100-year flood elevation.*

Settlement
Total and differential settlement will occur when new loads (fill or buildings) are placed at the site causing consolidation of the refuse and underlying bay mud soils. Differential settlement can damage buildings and site improvements. The vast majority of the project site is underlain by existing landfill cap soils and refuse over bay mud, and preliminary plans indicate that new improvements may require new fills locally in excess of 10-feet thick. Therefore, the risk of potential damage to improvements due to settlement is high.

Evaluation: *Less than significant with mitigation.*
Mitigation: *Settlement analyses should be performed as part of a future design-level geotechnical investigation once project grading plans are well-developed and the locations of proposed structures are confirmed. Settlement mitigation may include a combination of measures, including the use of lightweight fill, placement of pre-construction surcharge fills and wick drains, use of deep foundation systems in areas beyond the limits of the former landfill (where deep foundation construction may be an option), and/or the use of rigid shallow foundation systems designed to accommodate future settlements for structures within the limits of the landfill. Anticipated future settlements should be considered during design of new site improvements, including new underground utilities and site drainage systems. Additional discussion and preliminary recommendations regarding site grading, new fill slopes, probable foundation types, and settlement mitigation are presented in the Conclusions and Recommendations section of this report.*

[8] Association of Bay Area Governments (ABAG)(2014), "Interactive Flood Maps", accessed November 17, 2014, http://gis.abag.ca.gov/website/Hazards/?hlyr=femaZones,.

Conclusions

Based on our site reconnaissance and review of available reference material, we judge the proposed project is feasible from a geologic and geotechnical standpoint. However, there are several geotechnical challenges to be considered during project design in the interest of overall project viability and cost-efficiency. Primary geotechnical considerations for the project will include providing foundation support for new structures design to resist some long-term total and differential settlements. Potential differential settlement are primarily in zones between existing and new fills in areas underlain by bay mud. Preliminary geotechnical recommendations and development guidelines to address these and other geotechnical items are provided in the following sections.

Preliminary Recommendations and Development Guidelines

1. Project Layout/Location of New Structures - We understand that many factors, including USACE regulations, neighbor and stakeholder concerns, permitting issues, design and construction costs, and others, will control project design development. Current plans indicate the majority of new structures will be located around the perimeter of the landfill area. If feasible, siting of new structures on the edge of the existing landfill cap should be avoided since these are zones of higher potential differential settlement. Otherwise, mitigation of potential differential settlement will be needed. Mitigation measures could include pre-consolidation of the bay mud by surcharge and/or wick drainage. Rigid shallow foundations should be utilized to minimize penetrations into the landfill cap and resist possible future long term differential settlements.

2. Seismic Design - Minimum mitigation of ground shaking includes seismic design of new structures in conformance with the provisions of the most recent edition (2010) of the California Building Code. The magnitude and character of these ground motions will depend on the particular earthquake and the site response characteristics. Based on the interpreted subsurface conditions and close proximity of the Hayward, Rodgers Creek, and San Andreas Faults, we recommend the CBC coefficients and site values shown in Table C below for use in equations 16-37(1) and 16-38 to calculate the design base shear of the new construction. To determine site seismic coefficients, we used the USGS Seismic DesignMaps web application (2008) and the latitude and longitude coordinates shown on Figure 4.

   Note that, since preliminary plans currently show all new structures sited in areas underlain by bay mud and/or existing landfill refuse/cap materials, we have provided seismic criteria for Site Class “E” (soft clay soils). Seismic design criteria should be verified during a future design-level geotechnical investigation once the locations of proposed structures have been finalized.

TABLE C
SEISMIC DESIGN CRITERIA
Marin Sports Academy
Novato, California

2013 California Building Code

Factor Name	Coefficient	CBC Table/ Figure[1]	Site Specific Value[2,3,4]
Site Class[5]	$S_{A,B,C,D,E,\text{ or }F}$	1613.5.2	S_E
Spectral Acc. (short)	S_S	1613.5(3)	1.50 g
Spectral Acc. (1-sec)	S_1	1613.5(4)	0.60 g
Site Coefficient	F_a	1613.5.3(1)	0.9
Site Coefficient	F_v	1613.5.3(2)	2.4

(1) For facilities regulated by the Division of the State Architect – Structural Safety (DSA-SS), the Office of Statewide Health Planning and Development (OSHPD), or other agencies (e.g. schools, hospitals, etc.) use the "A" equations and tables in lieu of the equations and tables noted above. "Site specific" values in the table apply to all structures.

(2) Values determined in accordance with the 2010 ASCE-7 standard.

(3) Values determined using the USGS Seismic DesignMaps web application, http://earthquake.usgs.gov/designmaps/us/application.php, accessed November 19, 2014.

(4) Values determined using Vs^{30} = 183 m/s for Site Class "E" per the 2013 CBC.

(5) Soil Profile Type S_E ("Site Class E") Description: Soft Clay Soil, shear wave velocity less than 600 feet per second, Standard Penetration Test (SPT) blow counts less than 15, and undrained shear strength less than 1,000 pounds per square foot.

3. Site Grading – We anticipate that moderate to major site grading will be required to facilitate construction of the proposed improvements, consisting chiefly of fill placement in order to provide sufficiently-uniform grades and slopes for the planned athletic fields. Since excavations into the existing landfill cap area will be severely limited by USACE regulations, only limited excavation into native soils, generally for ancillary improvements or to provide keyways for new fill slopes, is expected. Excavations into native materials will likely yield clayey to sandy mixture that may be suitable for re-use as fill, provided they can be processed to meet the gradation limits shown in Table D. Bay mud will not be suitable for re-use as fill, and should be removed from the site. All fill materials should be non-expansive materials free of organic matter, have a Liquid Limit of less than 40, a Plasticity Index of less than 20, minimum R-value of 20, and conform to the gradation limits shown in Table D.

TABLE D
FILL SOIL GRADATION LIMITS
Marin Sports Academy
Novato, California

Particle Size	Percent Finer by Dry Weight
4 inch	100
No. 4 sieve	20 - 100
No. 200 sieve	0 - 50

Where new fills are planned on areas underlain by existing landfill materials or bay mud, additional future settlements should be anticipated. Design of site improvements, including finished grades, structure foundations, new utilities, site drainage, and other improvements, should take into account anticipated future settlements to ensure long-term function and reduce anticipated future maintenance. Once project grading plans are better-developed, settlement and liquefaction analyses should be performed as part of a future design-level investigation.

4. Cut and Fill Slopes – New cut slopes should not be planned within the existing landfill cap area since excavations into the cap will not be allowed by USACE. If new cut slopes are planned in areas underlain by native materials and not subject to restrictions imposed on excavations by USACE, they should generally be no steeper than 3:1 (horizontal:vertical). Specific evaluation will be required for planned cut slopes steeper than 3:1

   Most of the planned new fills would be sited in areas underlain by bay mud, and will therefore require specific settlement and slope-stability analyses be performed during a future design-level geotechnical investigation. In general, we judge these new fill slopes will be feasible to construct, but significant long-term total settlements should be anticipated. Some mitigation measures to reduce long term settlement include surcharge preloading and vertical wick drains to accelerate settlement or use of lightweight fill (geo-foam blocks, lightweight foam concrete or lava rock). Locating proposed structures completely on or off the existing landfill would reduce needed pre-construction mitigations and anticipated future maintenance of structures affected by differential settlements. New fills should generally not be steeper than 3:1; if steeper fill slopes are planned, they will need to be specifically designed to incorporate appropriate geosynthetic reinforcement and drainage provisions.

5. Foundations – Since deep foundation may be difficult to permit and construct within the limits of the existing landfill cap, we judge that new structures should incorporate rigid shallow foundation systems wherever possible. Suitable rigid foundation options generally include thickened mat slabs, post-tensioned slabs, and “waffle-grid” type slab systems. Since there is some risk of lurching or ground cracking around the tops of slopes during a seismic event, we recommend that new structures be setback a minimum of 15-feet from the nearest adjacent top of slope. This recommendation may be revised based on additional analyses performed during a future design-level investigation once project plans are better-developed.

Where new structures are planned beyond the limits of the landfill cap and in areas not subject to restrictions on excavation by USACE, shallow foundation systems described above will still be an option. However, for better long-term performance, mitigation of potential liquefaction, lurching/ground cracking, and settlement hazards, and reduction of expected future maintenance, deep foundations bearing on firm materials could be considered. Deep foundations in areas underlain by bay mud or saturated, collapsible sands would likely consist of driven or displacement piles since “traditional” cast-in-drilled-hole (CIDH) pier construction is typically difficult and expensive in such conditions. In areas underlain by more competent materials, CIDH piers will likely be the most cost-effective deep foundation system.

6. Site Drainage – Although the site currently contains slopes that will drain, grading for new improvements may result in adverse drainage patterns that could cause water to pond around structures or exacerbate or accelerate surface erosion in exposed soil areas. Placement of new fills will induce additional future settlements that should be accounted for during design of finished grades and new site drainage facilities. Additionally, construction of new deep subsurface drainage within the existing landfill area will be hindered by excavation restrictions imposed by USACE, and drainage in these areas will need to be accomplished by surface improvements and careful design of finished grades.

   We recommend that building areas be raised slightly and that adjoining landscaped areas be sloped downward at least 0.25 feet per 5 feet (5%) away from the perimeter of building foundations. Area drains should be provided for landscape planters adjacent to new structures. Where hard surfaces, such as concrete or asphalt, adjoin foundations, these areas should be sloped downward at least 0.1 feet in the first 5 feet (2%) away from the structure. Roof gutter downspouts may discharge onto hard surfaces, but should not discharge into landscape areas or into foundation or retaining wall subdrain systems. Runoff from area drains and roof gutter downspouts should be collected into a storm drain system and discharged at a location and in a manner so as to minimize the potential for adverse erosion.

   Existing drainage outlets from the landfill will need to be extended and connected into the new storm drainage system for the planned development.

Supplemental Services

We anticipate that future services will include a design-level geotechnical investigation, to be performed following preliminary project approval and as project plans become better-defined. We will consult with the design team and attend project meeting as needed. Future geotechnical services may include observation and testing during construction. We will be happy to provide a scope and budget proposal for any desired supplemental service.

We trust that this letter presents the information you require at this time. Should there be any questions or concerns regarding our feasibility evaluation, please do not hesitate to contact us.

Very truly yours,
MILLER PACIFIC ENGINEERING GROUP

REVIEWED BY

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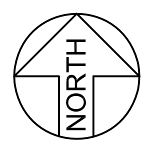
Attachments: Figures 1 through 7

SITE LOCATION MAP

NO SCALE

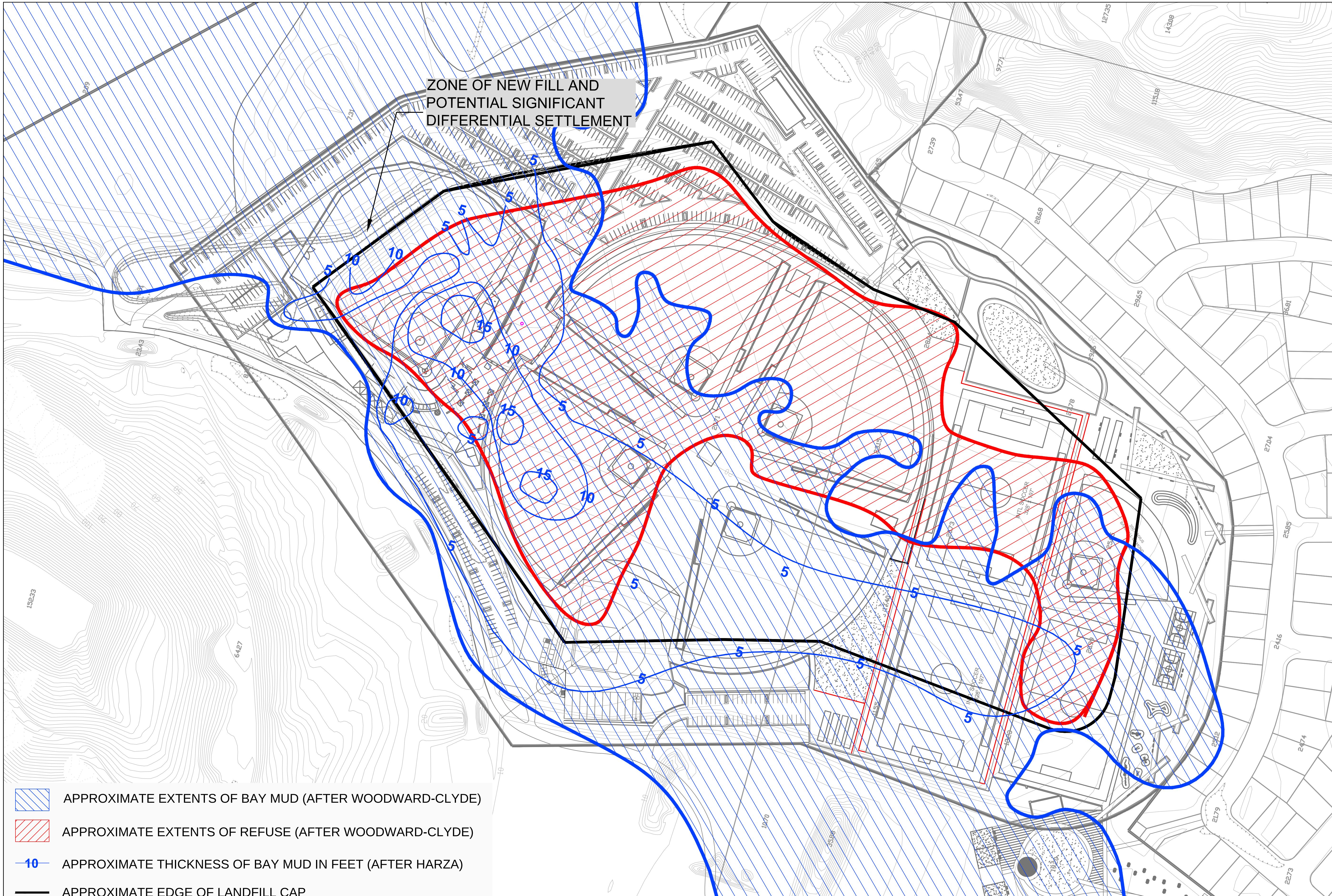
SITE: LATITUDE, 38.064°
LONGITUDE, -122.524°



REFERENCE: Google Earth, 2014

Miller Pacific ENGINEERING GROUP	504 Redwood Blvd. Suite 220 Novato, CA 94947 T 415 / 382-3444 F 415 / 382-3450 www.millerpac.com	SITE LOCATION MAP
		Marin Sports Acedemy Novato, California — Project No. 2095.001 Date: 11/12/14
		Drawn MFJ Checked
		1 FIGURE

FILE: 2095.001SLM.dwg



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FILE: 2095.001SP.dwg

Designed MFJ
Drawn MFJ
Checked

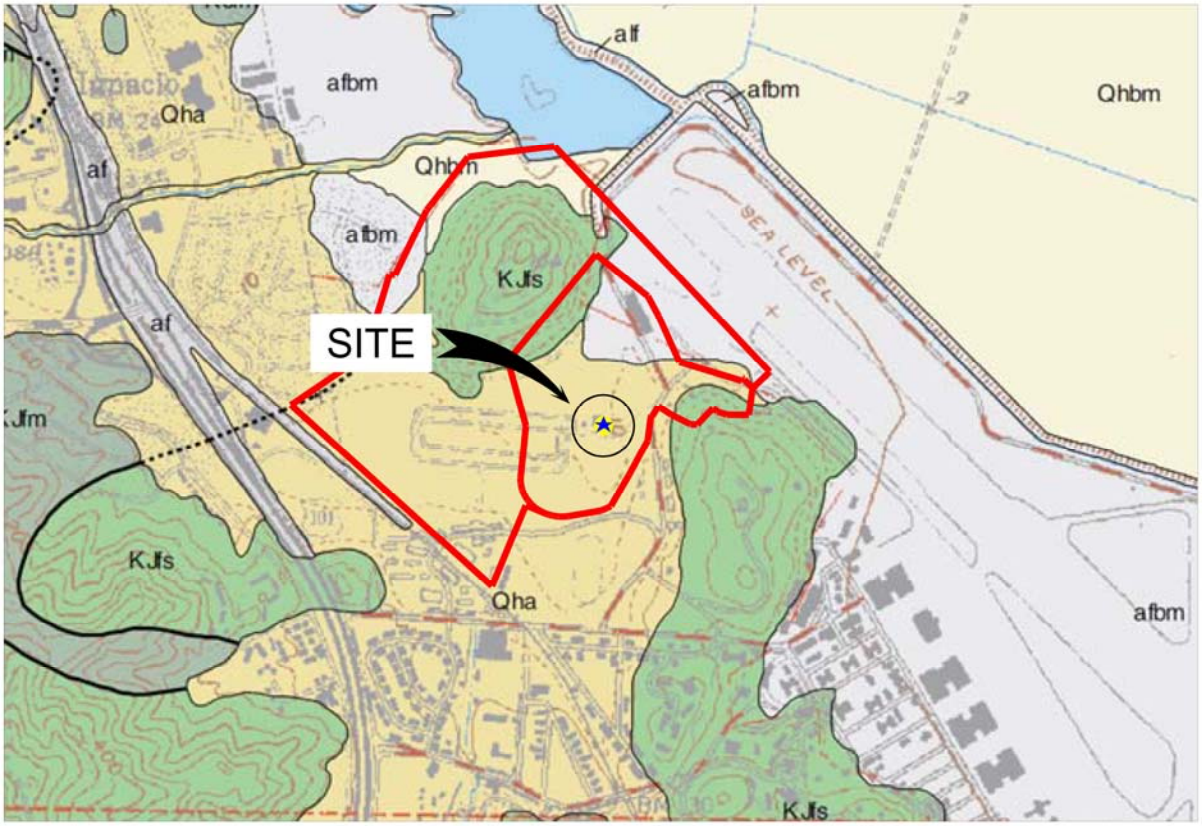
SITE PLAN

Marin Sports Academy
Novato, California

Project No. 2095.001

Date: 11/17/14

FIGURE
2



REGIONAL GEOLOGIC MAP

(NOT TO SCALE)

LEGEND AND KEY TO MAP SYMBOLS

af	ARTIFICIAL FILL (HOLOCENE)
afbm	ARTIFICIAL FILL OVER BAY MUD (HOLOCENE)
Qhbm	BAY MUD (HOLOCENE) Typically soft, compressible silty clay with lesser quantities of fine sand and peat deposited in tidal marsh, estuary, lagoon, or delta environments.
Qha	ALLUVIUM (HOLOCENE) Variable proportions of poorly- to moderately-consolidated clay, silt, sand and gravel deposited on fans, terraces, or in basins.
KJfs	FRANCISCAN COMPLEX SANDSTONE AND SHALE (JURASSIC-CRETACEOUS) Thick-bedded arkosic sandstone and interbedded shale.
	GEOLOGIC CONTACT, DASHED WHERE APPROXIMATE, DOTTED WHERE CONCEALED
	APPROXIMATE PARCEL BOUNDARIES

REFERENCE: Rice, S.R. et al (2002), "Geologic Map of the Novato 7.5' Quadrangle, Marin and Sonoma Counties, California: A Digital Database, Version 1.0", California Department of Conservation, California Geological Survey, Map Scale 1:24,000.

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REGIONAL GEOLOGIC MAP

Marin Sports Academy
Novato, California

Project No. 2095.001 Date: 11/14/14

Drawn MFJ
Checked

3
FIGURE

LEGEND

SITE: LATITUDE, 38.064°
LONGITUDE, -122.524°

NORTH

FAULT	TYPE	CBC DESCRIPTION
(solid red line)	"A"	CAPABLE OF LARGE MAGNITUDE EARTHQUAKES AND HIGH RATE OF SEISMIC ACTIVITY
(dashed blue line)	"B"	CAPABLE OF LARGE MAGNITUDE EARTHQUAKES OR HIGH RATE OF SEISMIC ACTIVITY

21% PROBABILITY OF M≥6.7 BETWEEN 2008-2038 FOR FAULTS SHOWN. OVERALL PROBABILITY OF 63% IN BAY AREA OF ONE OR MORE M≥6.7 EARTHQUAKES FROM 2008-2038.

REFERENCES:
1) ACTIVE FAULT MAP MODIFIED FROM SUMMARY OF EARTHQUAKE PROBABILITIES IN THE S.F. BAY REGION, 2008-2038, THE 2007 WORKING GROUP ON CALIFORNIA EARTHQUAKE PROBABILITIES, 2008.

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FILE: 2095.001FM.dwg

ACTIVE FAULT MAP

Marin Sports Academy
Novato, California

Project No. 2095.001 Date: 11/12/14

Drawn MFJ
Checked

4
FIGURE

Map Reference: ABAG Geographic Information System, *Interactive Liquefaction Susceptibility Map*, http://gis.abag.ca.gov/website/liquefactionsusceptibility/index.html, accessed August 28, 2013.

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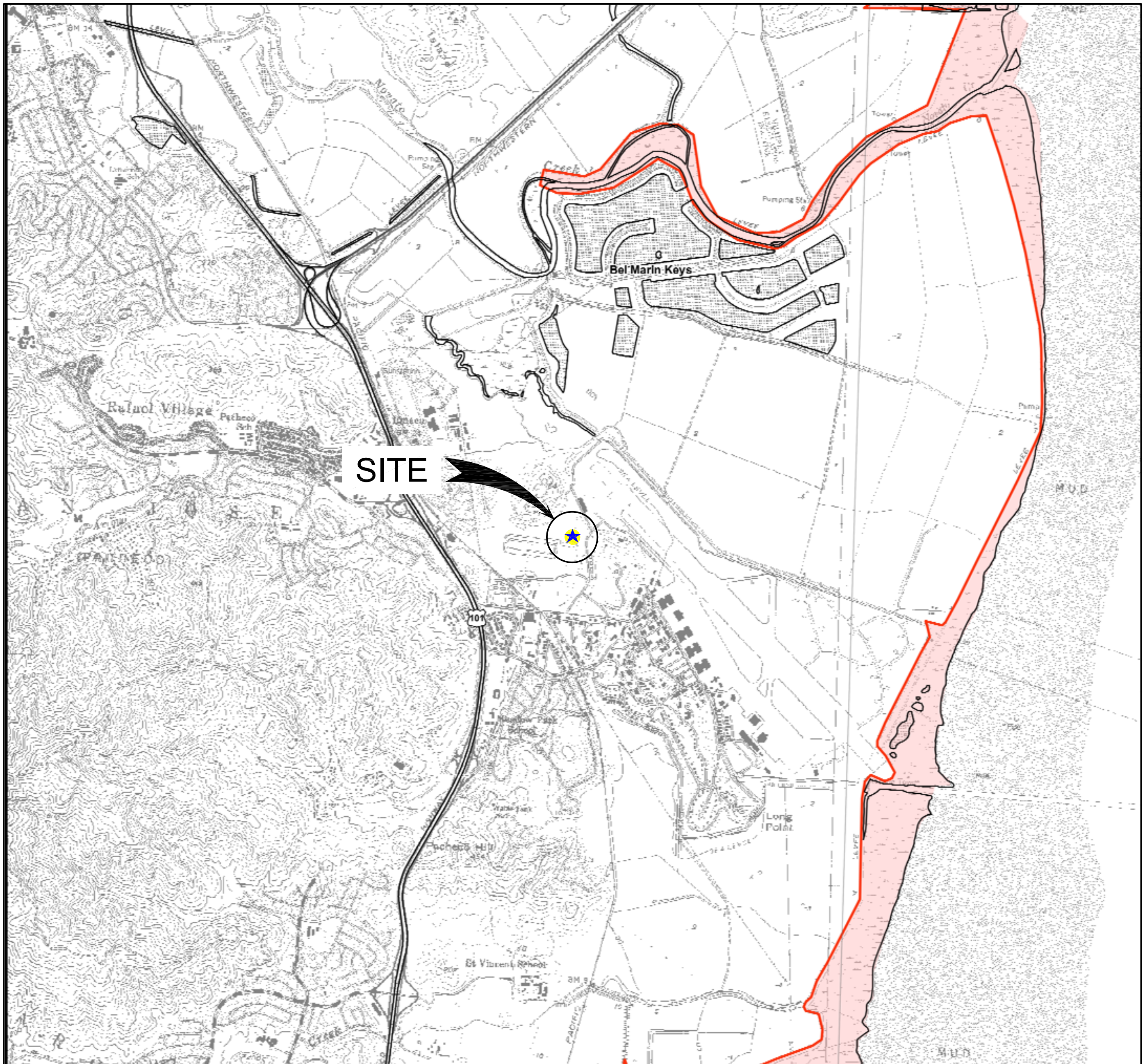
A CALIFORNIA CORPORATION, © 2010, ALL RIGHTS RESERVED FILE: 2095.001LM.dwg			5 FIGURE



TSUNAMI INUNDATION MAP

(NO SCALE)

NORTH

MAP KEY

Tsunami Inundation Line

Tsunami Inundation Area

Mean High Tide Line

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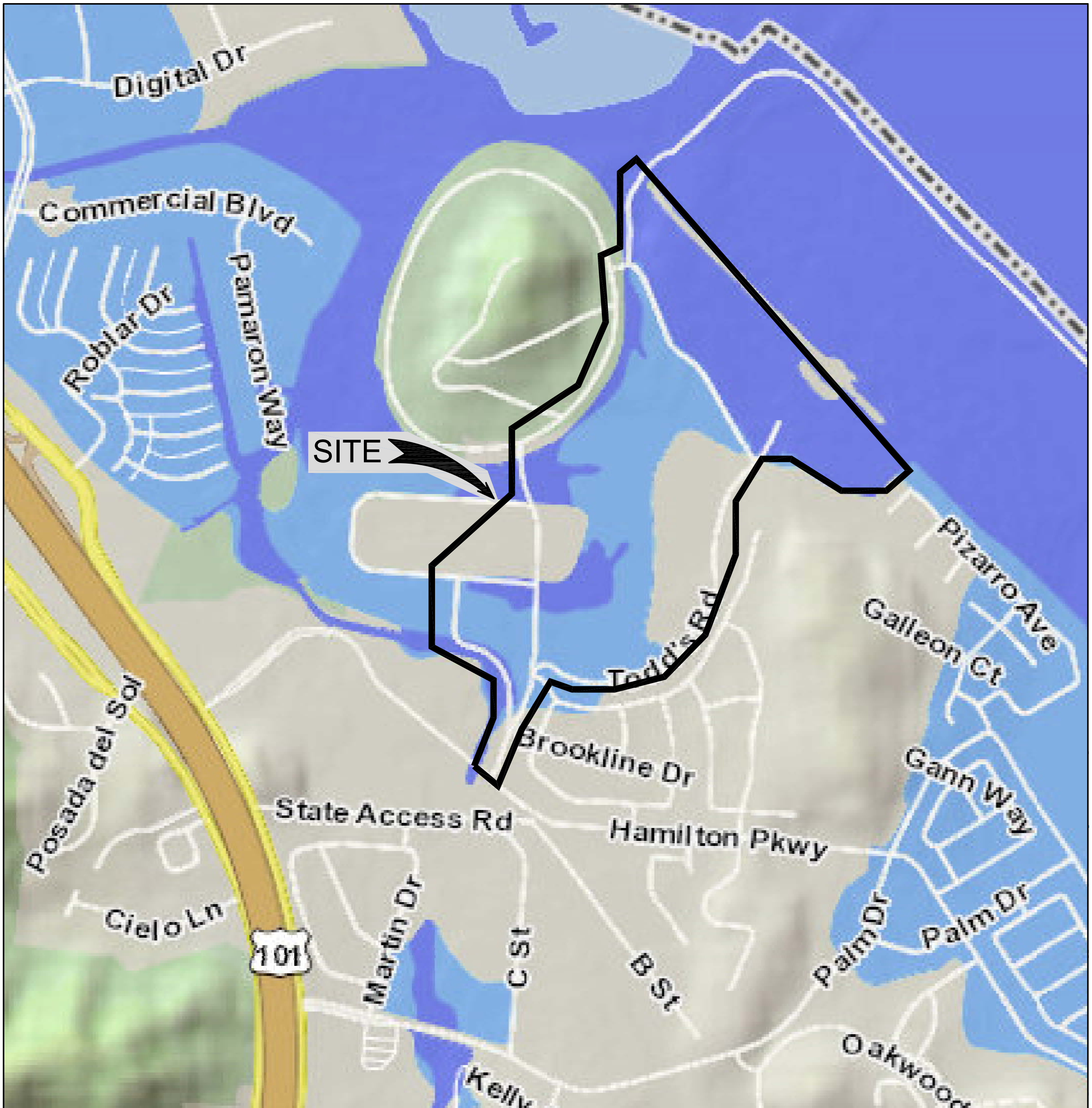
FILE: 2095.001TM.dwg



FEMA FLOOD ZONE MAP

(NO SCALE)

FEMA 100-year flood zone

FEMA 500-year flood zone

NORTH

REFERENCE: Association of Bay Area Governments (ABAG)(2014), "Interactive Flood Maps", http://gis.abag.ca.gov/website/Hazards/?hlyr=femaZones, accessed November 17, 2014. (data compiled from current FEMA Digital Flood Insurance Rate Maps (DFIRMS)

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FILE: 2095.001FLM.dwg

FEMA FLOOD ZONE MAP

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Novato, California

Project No. 2095.001 Date: 11/17/14

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Checked

7
FIGURE